AMENDMENTS TO THE CLAIMS

This listing of changes will replace all prior versions, and listings, of claims in the specification:
Listing of Claims:

1. (Original) A method of manufacturing a silicon single crystal, comprising rotating a quartz crucible (13) for storing a silicon melt (12) at a predetermined rotation speed, rotating a silicon single crystal ingot (25) pulled from the silicon melt (12) in an opposite direction to the rotation of the quartz crucible (13) at a predetermined rotation speed, and pulling the silicon single crystal ingot (25) at a pull rate such that an interior of the silicon single crystal ingot (25) becomes a perfect region in which agglomerates of interstitial silicon-type point defects and agglomerates of vacancy-type point defects are absent:

wherein an average rotation speed CR_{TAV} of the quartz crucible (13) during the pulling of a top ingot portion (25a) of the silicon single crystal ingot (25) is set faster than an average rotation speed CR_{BAV} of the quartz crucible (13) during the pulling of a bottom ingot portion (25b) of the silicon single crystal ingot (25).

2. (Original) The method of manufacturing a silicon single crystal according to claim 1, wherein the average rotation speed CR_{TAV} is set to be within the range of from 5 to 10 rpm, the average rotation speed CR_{BAV} is set to be within the range of from 3 to 8 rpm, and the difference between the average rotation speed CR_{TAV} and the average rotation speed CR_{BAV} is set to be within the range of from 0.1 to 7 rpm.

3. (Original) A method of manufacturing a silicon single crystal, comprising rotating a quartz crucible (13) for storing a silicon melt (12) at a predetermined rotation speed, rotating a silicon single crystal ingot (25) pulled from the silicon melt (12) in an opposite direction to the rotation of the quartz crucible (13) at a predetermined rotation speed, and pulling the silicon single crystal ingot (25) at a pull rate such that an interior of the silicon single crystal ingot (25) becomes a perfect region in which agglomerates of interstitial silicon-type point defects and agglomerates of vacancy-type point defects are absent:

wherein a ratio SR_{TAV}/CR_{TAV} of an average rotation speed SR_{TAV} of the silicon single crystal

ingot (25) and an average rotation speed CR_{TAV} of the quartz crucible (13) during the pulling of a top ingot portion (25a) of the silicon single crystal ingot (25) is set to be equal to or smaller than a ratio SR_{BAV}/CR_{BAV} of an average rotation speed SR_{BAV} of the silicon single crystal ingot (25) and an average rotation speed CR_{BAV} of the quartz crucible (13) during the pulling of a bottom ingot portion (25b) of the silicon single crystal ingot (25).

4. (Original) The method of manufacturing a silicon single crystal according to claim 3, wherein the ratio SR_{TAV}/CR_{TAV} is set to be within the range of from 2.0 to 3.6, the ratio SR_{BAV}/CR_{BAV} is set to be within the range of from 2.0 to 18, and (the ratio SR_{TAV}/CR_{TAV} – the ratio SR_{BAV}/CR_{BAV}) is set to be within the range of from –16 to 0.

5. (Original) The method of manufacturing a silicon single crystal according to claim 1, wherein:

a heat shield member (36) is interposed between an outer circumferential surface of the silicon single crystal ingot (25) pulled from the silicon melt (12) and a heater (13) surrounding the quartz crucible (13);

the heat shield member (36) is positioned above a surface of the silicon melt (12) at a gap and has a cylindrical portion (37) surrounding the outer circumferential surface of the silicon single crystal ingot (25), and a bulging portion (41) provided at a lower portion of the cylindrical portion (37) bulging inwardly of the cylindrical portion and having a heat-storing member (47) in an interior thereof; and

a diameter d is 100 mm or more where d is a diameter of the silicon single crystal ingot (25), a height (H_1) of an inner circumferential surface of the heat-storing member (47) is 10 to d/2 mm, and a minimum gap (W_1) between an inner circumferential surface of the heat-storing member (47) and the outer circumference of the silicon single crystal ingot (25) is 10 to 0.2d mm.

6. (Original) The method of manufacturing a silicon single crystal according to claim 2, wherein:

a heat shield member (36) is interposed between an outer circumferential surface of the silicon single crystal ingot (25) pulled from the silicon melt (12) and a heater (13) surrounding the quartz crucible (13);

the heat shield member (36) is positioned above a surface of the silicon melt (12) at a gap

and has a cylindrical portion (37) surrounding the outer circumferential surface of the silicon single crystal ingot (25), and a bulging portion (41) provided at a lower portion of the cylindrical portion (37) bulging inwardly of the cylindrical portion and having a heat-storing member (47) in an interior thereof; and

a diameter d is 100 mm or more where d is a diameter of the silicon single crystal ingot (25), a height (H_1) of an inner circumferential surface of the heat-storing member (47) is 10 to d/2 mm, and a minimum gap (W_1) between an inner circumferential surface of the heat-storing member (47) and the outer circumference of the silicon single crystal ingot (25) is 10 to 0.2d mm.

7. (Original) The method of manufacturing a silicon single crystal according to claim 3, wherein:

a heat shield member (36) is interposed between an outer circumferential surface of the silicon single crystal ingot (25) pulled from the silicon melt (12) and a heater (13) surrounding the quartz crucible (13);

the heat shield member (36) is positioned above a surface of the silicon melt (12) at a gap and has a cylindrical portion (37) surrounding the outer circumferential surface of the silicon single crystal ingot (25), and a bulging portion (41) provided at a lower portion of the cylindrical portion (37) bulging inwardly of the cylindrical portion and having a heat-storing member (47) in an interior thereof; and

a diameter d is 100 mm or more where d is a diameter of the silicon single crystal ingot (25), a height (H_1) of an inner circumferential surface of the heat-storing member (47) is 10 to d/2 mm, and a minimum gap (W_1) between an inner circumferential surface of the heat-storing member (47) and the outer circumference of the silicon single crystal ingot (25) is 10 to 0.2d mm.

8. (Original) The method of manufacturing a silicon single crystal according to claim 4, wherein:

a heat shield member (36) is interposed between an outer circumferential surface of the silicon single crystal ingot (25) pulled from the silicon melt (12) and a heater (13) surrounding the quartz crucible (13);

the heat shield member (36) is positioned above a surface of the silicon melt (12) at a gap and has a cylindrical portion (37) surrounding the outer circumferential surface of the silicon single crystal ingot (25), and a bulging portion (41) provided at a lower portion of the cylindrical portion

(37) bulging inwardly of the cylindrical portion and having a heat-storing member (47) in an interior thereof; and

a diameter d is 100 mm or more where d is a diameter of the silicon single crystal ingot (25), a height (H_1) of an inner circumferential surface of the heat-storing member (47) is 10 to d/2 mm, and a minimum gap (W_1) between an inner circumferential surface of the heat-storing member (47) and the outer circumference of the silicon single crystal ingot (25) is 10 to 0.2d mm.

9. (Original) The method of manufacturing a silicon single crystal according to claim 1, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being obtained by the following Equation (1):

$$S = (Po/E) \times F/A \qquad (1)$$

where Po is an atmospheric pressure (Pa) outside an chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow rate (m^3/second) of the inert gas supplied to the chamber (11) at the pressure Po (Pa) at room temperature, and A is a cross-sectional area (m^2) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

10. (Original) The method of manufacturing a silicon single crystal according to claim 2, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being obtained by the following Equation (1):

$$S = (Po/E) \times F/A \qquad (1)$$

where Po is an atmospheric pressure (Pa) outside an chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow rate (m^3/second) of the inert gas supplied to the chamber (11) at the pressure Po (Pa) at room temperature, and A is a cross-sectional area (m^2) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

11. (Original) The method of manufacturing a silicon single crystal according to claim 3, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being

obtained by the following Equation (1):

$$S = (Po/E) \times F/A \qquad (1)$$

where Po is an atmospheric pressure (Pa) outside an chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow rate (m^3/second) of the inert gas supplied to the chamber (11) at the pressure Po (Pa) at room temperature, and A is a cross-sectional area (m^2) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

12. (Original) The method of manufacturing a silicon single crystal according to claim 4, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being obtained by the following Equation (1):

$$S = (Po/E) \times F/A \qquad (1)$$

where Po is an atmospheric pressure (Pa) outside an chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow rate (m^3/second) of the inert gas supplied to the chamber (11) at the pressure Po (Pa) at room temperature, and A is a cross-sectional area (m^2) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

13. (Original) The method of manufacturing a silicon single crystal according to claim 5, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being obtained by the following Equation (1):

$$S = (Po/E) \times F/A \qquad (1)$$

where Po is an atmospheric pressure (Pa) outside an chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow rate (m^3/second) of the inert gas supplied to the chamber (11) at the pressure Po (Pa) at room temperature, and A is a cross-sectional area (m^2) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

14. (Original) The method of manufacturing a silicon single crystal according to claim 6, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being

obtained by the following Equation (1):

$$S = (Po/E) \times F/A \qquad (1)$$

where Po is an atmospheric pressure (Pa) outside an chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow rate (m^3/second) of the inert gas supplied to the chamber (11) at the pressure Po (Pa) at room temperature, and A is a cross-sectional area (m^2) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

15. (Original) The method of manufacturing a silicon single crystal according to claim 7, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being obtained by the following Equation (1):

$$S = (Po/E) \times F/A \qquad (1)$$

where Po is an atmospheric pressure (Pa) outside an chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow rate (m^3/second) of the inert gas supplied to the chamber (11) at the pressure Po (Pa) at room temperature, and A is a cross-sectional area (m^2) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

16. (Original) The method of manufacturing a silicon single crystal according to claim 8, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being obtained by the following Equation (1):

$$S = (Po/E) \times F/A \qquad (1)$$

where Po is an atmospheric pressure (Pa) outside an chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow rate (m^3/second) of the inert gas supplied to the chamber (11) at the pressure Po (Pa) at room temperature, and A is a cross-sectional area (m^2) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

17. (Currently amended) A silicon single crystal manufactured by a method according to ~~any one of claims~~ claim 1 ~~through 17~~.

18. (New) A silicon single crystal manufactured by a method according to claim 3.